UNIVERSITY OF WASHINGTON

CREATING AND CHANGING UNDERGRADUATE ACADEMIC PROGRAMS

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College/Campus Arts & Sciences/UW Seattle	**Department/Unit** Physics	**Date** 10 Feb 2010

New Programs

- ☐ Leading to a Bachelor of _____ in _____ degree.
- ☐ Leading to a Bachelor of _____ degree with a major in _____.
- ■ Leading to a Biophysics Option within the existing major in Physics.
- ☐ Leading to a minor in _____

Changes to Existing Programs

- ☐ New Admission Requirements for the Major in _____ within the Bachelor of _____.
- ☐ Revised Admission Requirements for the Major in _____ within the Bachelor of _____.
- ■ Revised Program Requirements for the Major in Physics within the Bachelor of Science.
- ☐ Revised Requirements for the Option in _____ within the major in _____.
- ☐ Revised Requirements for the Minor in _____.

Other Changes

- ☐ Change name of program from _____ to _____.
- ☐ New or Revised Continuation Policy for _____.
- ☐ Eliminate program in _____.

Proposed Effective Date: **Quarter:** ■ Autumn ☐ Winter ☐ Spring ☐ Summer **Year:** 20 10

Contact Person: Prof. Marjorie Olmstead	Phone: 5-3031	Email: olmstd@uw.edu	Box: 351560

EXPLANATION OF AND RATIONALE FOR PROPOSED CHANGE

For new program, please include any relevant supporting documentation such as student learning outcomes, projected enrollments, letters of support and departmental handouts. (*Use additional pages if necessary*).

The physics department at UW regularly ranks in the top three in the nation in terms of the number of BS degrees awarded per year (Harvard and Berkeley are the other two), graduating about 60 majors each year. Our large undergraduate major community encompasses students with varied interests and career goals, and we propose to modify our current general physics degree requirements to create four distinct options to meet the diverse needs of our major community. To accomplish this within a reasonable number of credits we are removing some requirements from the existing degree program and replacing them with four sets of new requirements more tailored to students' specific career goals. In addition, incremental modifications to department course offerings over the past few years have resulted in the removal of some courses that used to provide a less mathematically intensive path to a degree and the creation of new courses that need a home in the major requirements. The new options will also improve the department's ability to advise students, since faculty advisors with particular knowledge of these areas can interact with students starting from when they declare the physics major. The four new options are: Comprehensive Physics, Applied Physics, Teaching Preparation and Biophysics. Each is detailed on a separate form 1503.

SEE ATTACHED for ADDITIONAL INFORMATION, including both general information on the new degree programs and specific information on the Biophysics Option.

OTHER DEPARTMENTS AFFECTED

List all departments/units/ or co-accredited programs affected by your new program or changes to your existing program and acquire the signature of the chair/director of each department/unit listed. Attach additional page(s) if necessary. *See online instructions.

Department/Unit:	Chair/Program Director:	Date:
Physics	[signature]	8/27/10
Department/Unit:	Chair/Program Director	Date:
Chemistry	[signature]	8/19/10

CATALOG COPY

Catalog Copy as currently written. Include only sections/paragraphs that would be changed if your request is approved. Please cross out or otherwise highlight any deletions.

PLEASE SEE ATTACHED

PROPOSED CATALOG COPY

Reflecting requested changes (Include exact wording as you wish it to be shown in the printed catalog. Please underline or otherwise highlight any additions. If needed, attach a separate, expanded version of the changes that might appear in department publications). **Please note:** all copy will be edited to reflect uniform style in the General Catalog.

PLEASE SEE ATTACHED. New material specific to Biophysics Option is repeated below:

Biophysics Track (106 credits, min.)
0. Common core requirements above, except only one course from the math menu required (2 recommended)
1. Mathematical Physics (4 credits): PHYS 228
2. Quantum and Statistical Mechanics (7 credits): PHYS 324, 328
3. Chemistry Principles (15 credits): CHEM 142, 152 and 162.
4. General Biology (10 credits): BIOL 180 and 200.
5. Biophysics (3 credits): PHYS 429
6. Additional Chemistry and Biology: (6 credits, min): Two courses from CHEM 223, 224, 428, 452, 453, BIOL 220, 340, 350, 355, 401, 427, 467, or BIOC 405 or 440.
7. Undergraduate Research (3 credits): Biology-related research under PHYS 499, BIOC 499, BIOL 499, CHEM 499, GENOME 499, MICROM 499, NBIO 499, PBIO 499, BIOEN 499.
8. Recommended: At least two additional courses from Chem/Bio menu in (6), plus BIOC 406 and MICROM 301

APPROVALS

Chair/Program Director:	Date:
College/School/Campus Curriculum Committee:	Date: 10/1/10
Dean/Vice Chancellor: Ara Mari Cence	Date: 10/1/10
Faculty Council on Academic Standards/ General Faculty Organization/Faculty Assembly Chair: John Schauberger	Date: OCT. 22, 2010

POST TRI-CAMPUS APPROVAL (when needed)

Faculty Council on Academic Standards/ General Faculty Organization/Faculty Assembly Chair:	Date:

OTHER DEPARTMENTS AFFECTED

List all departments/units/ or co-accredited programs affected by your new program or changes to your existing program and acquire the signature of the chair/director of each department/unit listed. Attach additional page(s) if necessary. *See online instructions.

Department/Unit:	Chair/Program Director:	Date:
Biology		8/9/10
Department/Unit:	Chair/Program Director	Date:
Chemistry		8/15/10

Addendum to Form 1503
Biophysics Option in a **Bachelor of Science in Physics**

Biophysics Track *(106 credits, min.)*

0. *Common core requirements, except only require 1 course from math menu; recommend 2 (58 credits)*
1. *Mathematical Physics (4 credits):* PHYS 228
2. *Quantum and Statistical Mechanics (7 credits):* PHYS 324, 328
3. *Chemistry Principles (15 credits):* CHEM 142, 152 and 162.
4. *General Biology (10 credits):* BIOL 180 and 200.
5. *Biophysics (3 credits):* PHYS 429
6. *Additional Chemistry and Biology (6 credits, min):* Two courses from CHEM 223, 224, 428, 452, 453, BIOC 405 or 440, and BIOL 220, 340, 350, 355, 401, 429.
7. *Undergraduate Research (3 credits):* Biology-related research in PHYS 401-403, BIOC 499, BIOL 499, CHEM 499, GENOME 499, MICROM 499, NBIO 499, PBIO 499, BIOEN 499.
8. Recommended: At least 2 additional courses from Chemistry/Biology menu in (6), BIOC 406 and MICROM 301

The ***Biophysics Option*** is aimed at the growing population working at the interface between physics and biology or medicine. It combines courses in physics, chemistry, biology and biochemistry to give students a thorough grounding in this interdisciplinary field. At the current time, physics offers only one course in biophysics (PHYS 429), which is required for the ***Biophysics Option***; it is hoped that as the population in this option builds over time, additional courses will be added to serve this population. Quantum and statistical mechanics (PHYS 324 and 328) are key elements of biological physics, and are thus specifically required (as opposed to a choice of 32x classes as in other options).

This option requires one year each of introductory chemistry and biology (the third quarter biology may be at a higher level), plus two additional quarters of organic, analytical or physical chemistry and a one-quarter introduction to biochemistry and molecular biology. The requirements for this option were developed in consultation with advisors in pre-Health Sciences, and are appropriate for students aimed at either medical school or a graduate program in biophysics, bioengineering, or medical physics.

The ***Biophysics Option*** requires a large number of credit hours (106 credits), and recommends several more. This is because this interdisciplinary area requires students be well-grounded in physics, chemistry and biology, while having a physics degree requires students take some upper-division physics classes. The load is similar to the biochemistry BS degree, which also requires introductory physics, biology and chemistry, adding upper division chemistry, genome sciences and biochemistry for a total of 107 credits. The ***Biophysics Option*** requires considerably fewer credits than a Bioengineering BS degree, which leaves very few credit hours unscripted: it requires 25 credits of math, 47 credits of introductory physics, chemistry, biology and biochemistry, plus 58 credits of advanced bioengineering (130 credits total).

The ***Biophysics Option*** will likely start as a small fraction of undergraduate physics majors, but given the expected growth of biophysics and medical physics in general, and interest we have heard our students express, the department anticipates this program will serve as an important source of new majors. UW has a very strong department of physiology and biophysics at the medical school, offering excellent UG research opportunities, but it does not offer an undergraduate degree.

OVERVIEW OF PROPOSED CHANGES TO PHYSICS BACHELOR OF SCIENCE PROGRAM
EFFECTIVE AUTUMN 2010
APPROVED BY PHYSICS DEPARTMENT FACULTY AUTUMN 2009

The department of physics proposes to change from a single "one major fits most" to four separate tracks, or options, depending on a student's career goals. Roughly 2/3 of the credits (61 credits) will form a common core, with the remainder focused towards a particular degree track. The new tracks are:

- ***Comprehensive Physics Option***: aimed at students planning to pursue graduate education in physics, astronomy or a related field.
- ***Applied Physics Option***: aimed at students planning to pursue technical employment with their bachelor of science degree
- ***Teaching Preparation Option***: aimed at students desiring a thorough grounding in physics before pursuing graduate education for a secondary teaching credential in physical science.
- ***Biophysics Option***: aimed at students wishing to pursue medical school, graduate school in medical physics or biophysics, or an MD/PhD program.

The physics department at UW regularly ranks in the top three in the nation in terms of the number of BS degrees awarded per year (Harvard and Berkeley are the other two), graduating about 60 majors each year. Our large undergraduate major community encompasses students with varied interests and career goals, and our curriculum and major requirements require revision to serve the diverse needs of our major community. To accomplish this within a reasonable number of credits we are removing some requirements from the existing degree program and replacing them with four sets of new requirements more tailored to students' specific career goals. In addition, incremental modifications to department course offerings over the past few years have resulted in the removal of some courses that used to provide a less mathematically intensive path to a degree and the creation of new courses that need a home in the major requirements. The new options will also improve the department's ability to advise students, since faculty advisors with particular knowledge of these areas can interact with students starting from when they declare the physics major.

With the current major requirements, students frequently end up with a mix of classes that does not adequately prepare them for their career choices with enough depth on any particular area. The new structure will ensure that they have sufficient depth in at least one area. For example, those aiming for graduate school are required to take the 300-level classes expected by the major graduate programs, while those aiming at a technical BS-level employment are required to take computer programming and additional laboratories. Students can also see from the requirements for other options what other courses they should take to broaden their preparation should they wish to preserve career flexibility.

Based on current interest, we anticipate that initially roughly 30-50% of our majors will choose each of the comprehensive and applied options; the other two options will start small, but the department expects they will form the basis for attracting new students to the physics major. The teaching preparation and biophysics tracks are designed to meet needs in which many current majors have expressed interest, but for which there is no current program.

Below, we first address the common core, and then the options.

COMMON CORE REQUIREMENTS

TABLE 1: CURRENT AND PROPOSED CORE REQUIREMENTS

	Current Core (61 cr)	Proposed Core (61 cr)
Phys	121, 122, 123 224, 225 227, *228* 321, 322 334	121, 122,123 224, 225, *226, 294* 227 321, 322 334
Math	124, 125, 126 308, 324	124, 125, 126 *Choose 2 from* {Math 307, 308, 309, 324, 326; AMath 351, 352, 353, 401}

Changes to core (in *red*): Two new 2nd-year classes developed over the past few years, PHYS 226 and PHYS 294, have been added to the core. PHYS 228, Mathematical Physics II, is removed from the core, but will still be taken by most of our majors. The upper-division math requirements are broadened to increase flexibility.

PHYS 226, Particles and Symmetries, forms a bridge between introductory modern physics (PHYS 225), and junior-level quantum mechanics (PHYS 324) with an emphasis on modern particle physics. The syllabus to PHYS 225 has been modified to include some of what used to be covered in PHYS 315 (no longer offered) and to complement PHYS 226. The two courses PHYS 225, 226 are now designed to provide a strong introduction to modern physics, greatly increasing the lower-division exposure of our students to physics discovered within the lifetime of our faculty. The initial introduction of this revision has gone well, and this change to core requirements reflects a desire to codify this in the major.

PHYS 294 is a new one-credit seminar introducing students to physics research on campus. It both serves as an overview of current topics in physics and as an introduction to potential research opportunities. It is added to increase physics majors' awareness of active research in their field. Currently optional, a large fraction of majors (and a number of non-majors) are taking this class, and it has been well received. Again, it is time to codify this into the major.

PHYS 228, Mathematical Physics II is traditionally a major gate-keeper class for the physics major. In the new curriculum, PHYS 228 will only be required for 3 of the 4 new options, but may be replaced by an additional course from a 300-level math menu in the applied physics track. This change relieves pressure on students who may learn math better from the math department than in a physics class, and allows the department to increase the focus in PHYS 228 on preparing students for the mathematical rigorous PHYS 324.

The other change in the core requirements is to broaden the choice for the upper-division math requirements. In this way, students may choose in which areas of math they would like more depth based on the overview of these topics presented in PHYS 227 and PHYS 228.

General Changes

Since PHYS 315 is no longer offered, an alternative was required for students who used to take this more phenomenological (and less mathematical) approach to modern quantum mechanics. Thus PHYS 324 is an elective for students in the applied track, as well as its pre-requisite mathematical physics class PHYS 228.

The current major requires 9 credits of (non-physics or astronomy) introductory science or history of science, which most students fulfill with chemistry, earth and space sciences, or biology. While we still strongly encourage students to broaden their education through introductory science, the department believes it is more important to add the new physics classes at the sophomore level (226, 294), and to restore the number of classes required at the 300 level to the level before the last restructuring of major requirements to account for the increase in credits from 3 to 4 in the core upper-division classes PHYS 227, 228, 321, 322, 324. Within the applied track, one elective may still be an introductory science or engineering class (options are modified somewhat from current requirement), and an additional class in computer programming is now required (AMATH 301), as well as a sophomore-level laboratory (PHYS 231). The other options add one or more requirements at the 300 or 400 level (see chart).

Upper division electives are revised to increase the number that must be classroom-based (as opposed to laboratory), and to require some specific electives for specific tracks: PHYS 429 for biophysics track; PHYS 407-8-9 for the teaching preparation track. Students currently must petition to replace one physics advanced laboratory with one of the advanced laboratories in astronomy (ASTR 480, 481); these classes are now explicitly allowed to meet major requirements. The upper division laboratory requirements are reduced for the teaching track (from 2 to 1) to allow time for the hands-on, laboratory based 407-8-9 sequence, and for the biophysics track (from 2 to 0) to allow time for biology and chemistry laboratories.

Details and motivation for the individual options are listed separately.

Concomitant Pre-Requisite Changes

These changes will require a few changes in prerequisites. Currently, MATH 308 is a pre/co-requisite for PHYS 227, and PHYS 228 is a pre/co-requisite for PHYS 321. We propose to change the pre-requisite for PHYS 227 to be any of the 300-level math classes, and to require only PHYS 227 for PHYS 321 and 322, while both PHYS 227 and 228 will be required for PHYS 324. Our experience with students who have obtained waivers from these pre-requisites in the past informs us that this will not cause significant problems for our students.

OPTIONS FOR THE BACHELOR OF SCIENCE IN PHYSICS

The major will be restructured into four options: i) Comprehensive Physics, aimed at students planning graduate study in physics or astronomy; ii) Applied Physics, aimed at students planning a technical career at the bachelor's level; iii) Teaching Preparation, aimed at students planning a career in secondary education; iv) Biophysics, aimed at students interested in a career in biological or medical physics; it is also an excellent preparation for medical school or an MD/PhD program. The generic degree encompassed by our current major program will be eliminated.

SUMMARY OF CHANGES IN NON-CORE PHYSICS MAJOR REQUIREMENTS

	Current (+29/28 cr)	Comprehensive (+32 cr)	Applied (+29/28 cr)	Teaching (+32 cr)	Biophysics (+54 cr)
Math	228	228	AMATH 301 228 OR +1 from core math menu	228	228
32x	324 *(or 315*)*	324 3 of 323, 325, 328, 329, A321, A322	*(324 meets elective option below)*	324 1 of 323,328,329	324 328
Adv. Lab	2 of 331, 335, 431, 432, 433, 434	2 of 331, 335, 431, 432, 433, 434, (A480 or A481)	231 2 of 331, 335, 431, 432, 433, 434, (A480 or A481)	1 of 331, 335, 431, 432, 433, 434, (A480 or A481)	*none*
UG Res	3 cr research or seminar	3 cr research or seminar	3 cr research or seminar	3 cr teaching	3 cr in bio-related research
Elective	2 additional Phys/Cognate Subjects, incl Lab	2 additional Phys/Cognate Class (not lab)	3 additional of 32x, Phys/Cognate (may include 1 lab; 1 intro sci)	all three of 407, 408, 409	429
Other Sci	9 credits intro science or history of science		*(selected intro science/ engineering in electives)*		5 chem 3 bio 1 biochem

*Listed in catalog as meeting modern physics requirement, but no longer offered after the creation of PHYS 226 and restructuring of the PHYS 225 syllabus.

Proposed Catalog Entry for Physics

Additions to current catalog highlighted in Yellow.

Physics

C121 Physics-Astronomy
www.phys.washington.edu
Physics is the study of the fundamental structure of matter and the interaction of its constituents, with the goal of providing a quantitative description of nature based on a limited number of physical principles.

Undergraduate Program

Adviser
C139A Physics-Astronomy, Box 351560
206-543-2772
The Department of Physics offers the following programs of study:
* The Bachelor of Science degree with a major in physics in any one of the following four options:

- Comprehensive Physics Track
- Applied Physics Track
- Teaching Preparation Track
- Biophysics Track

* A minor in physics

Bachelor of Science

Suggested First- and Second-Year College Courses: MATH 124, MATH 125, MATH 126 (or MATH 144, MATH 145, MATH 146), two or more courses from MATH 307, MATH 308, MATH 309, MATH 324, MATH 326 or AMATH 401; PHYS 121, PHYS 122, PHYS 123, PHYS 224, PHYS 225, PHYS 226, PHYS 227, PHYS 294. PHYS 228 is required for three of the four options, and recommended for the fourth; PHYS 231 is required for the applied option. (Note: MATH 134, MATH 135, and MATH 136 can be used in place of MATH 124, MATH 125, MATH 126, and MATH 308.)
These physics and mathematics courses are required prerequisites for junior-level work in physics not only at the UW but also at most colleges and universities in the United States. Students who do not complete them during the first two years in college will either need to take more than four years to earn a degree or will be limited to a minimal course of study for graduation in four years.

Department Admission Requirements

Students in good academic standing may declare the major at any time by visiting the department advising office to complete the necessary paperwork.

Major Requirements

Common Core for All Degree Options (61 credits)
1. *Core Physics courses (40 credits):* PHYS 121, PHYS 122, PHYS 123, PHYS 224, PHYS 225, PHYS 226, PHYS 227, PHYS 294, PHYS 321, PHYS 322, PHYS 334.
2. *Mathematics (21 credits):* MATH 124, MATH 125, MATH 126, and two from MATH 307 or AMATH 351, MATH 308 or AMATH 352, MATH 309 or AMATH 353, MATH 324, MATH 326 and AMATH 401,
3. At least 12 credits of the courses presented to satisfy requirements for the degree (not including undergraduate research credits) shall be in physics courses numbered 300 or above taken at the UW.
4. A minimum grade of 2.0 is required in all non-math courses presented in fulfillment of degree requirements.

Proposed Catalog Entry for Physics

Students may select any one of the following degree options:

Comprehensive-Physics Track *(93 credits, min)*

0. Common core requirements above
1. *Mathematical Physics (4 credits):* PHYS 228
2. *300-level courses in Physics or Astronomy (13 credits, min):* PHYS 324, plus at least 3 from PHYS 323, PHYS 325, PHYS 328, PHYS 329, ASTR 321, ASTR 322.
3. *Advanced Laboratory (6 credits, min):* Two courses from PHYS 331, 335, 431, 432, 433, 434, and ASTRO 480 OR 481.
4. *Upper-division lecture courses (6 credits, min):* Two courses from an approved list of upper-division lecture courses in physics or cognate subjects.
5. *Undergraduate Research (3 credits):* Three credits from PHYS 401-403, 485-487, or 491-496; ASTR 481 or 499 (ASTRO 481 may count as lab or research, but not both)

Applied-Physics Track *(89 credits, min)*

0. Common core requirements above
1. *Introductory Experimental Physics (3 credits):* PHYS 231
2. *Computer Programming (4 credits):* AMATH 301
3. *Additional Mathematics (3 credits, min):* PHYS 228 or an additional course from MATH 307 or AMATH 351, MATH 308 or AMATH 352, MATH 309 or AMATH 353, MATH 324, MATH 326 and AMATH 401 not used to satisfy Core Requirement
4. *Advanced Laboratory (6 credits, min):* Two courses from PHYS 331, 335, 431, 432, 433, 434, and ASTRO 480 OR 481
5. *Undergraduate Research (3 credits):* Three credits from PHYS 401-403, 485-487, or 491-496; ASTR 481 or 499 (ASTRO 481 may count as lab or research, but not both)
6. *Electives (9 credits, min):* Three additional courses from PHYS 323, 324, 325, 328, 329, approved list of upper-division lecture courses in physics or cognate subjects (same list as comprehensive requirement 4). May include one laboratory from above list and/or one class from the engineering/science applications list: AA 101, ASTRO 115, ATM S 211, CEE 220, CHEM E 220, EE 135, ESS 102, ME 123.

Teaching Preparation Track *(93 credits, min.)*

0. Common core requirements above
1. *Mathematical Physics (4 credits):* PHYS 228
2. *300-level courses in Physics (7 credits, min):* PHYS 324, plus at least 1 course from PHYS 323, PHYS 328, PHYS 329.
3. *Advanced Laboratory (3 credits, min):* One course from PHYS 331, 335, 431, 432, 433, 434, and ASTRO 480 OR 481
4. *Teaching Practicum (3 credits):* PHYS 401-2-3, working on a project that involves teaching.
5. *Physics for High School Teachers (15 credits):* PHYS 407, 408, 409.

Biophysics Track *(115 credits, min.)*

0. Common core requirements above
1. *Mathematical Physics (4 credits):* PHYS 228
2. *Quantum and Statistical Mechanics (7 credits):* PHYS 324, 328
3. *Chemistry Principles (15 credits):* CHEM 142, 152 and 162.
4. *General Biology (10 credits):* BIOL 180 and 200.
5. *Biochemistry (3 credits):* BIOC 405 or 440.
6. *Biophysics (3 credits):* PHYS 429

Proposed Catalog Entry for Physics

7. *Additional Chemistry (6 credits, min):* Two courses from CHEM 223, 224, 428, 452, 453.
8. *Additional Biology (3 credits, min):* One course from BIOL 220, 340, 350, 355, 401, 429.
9. *Undergraduate Research (3 credits):* Biology-related research under PHYS 401-403, BIOC 499, BIOL 499, CHEM 499, GENOME 499, MICROM 499, NBIO 499, PBIO 499, BIOEN 499.
10. Recommended: BIOC 406 and MICROM 301

Current Catalog Entry for Physics

Deleted items in ~~strikeout type~~
Items modified (moved or expanded) in new catalog highlighted in yellow.

Physics

C121 Physics-Astronomy
www.phys.washington.edu
Physics is the study of the fundamental structure of matter and the interaction of its constituents, with the goal of providing a quantitative description of nature based on a limited number of physical principles.

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The Department of Physics offers the following programs of study:
* The Bachelor of Science degree with a major in physics
* A minor in physics

Bachelor of Science

Suggested First- and Second-Year College Courses: MATH 124, MATH 125, MATH 126 (or MATH 144, MATH 145, MATH 146), MATH 308, MATH 324; PHYS 121, PHYS 122, PHYS 123, PHYS 224, PHYS 225, PHYS 227, PHYS 228. (Note: MATH 134, MATH 135, and MATH 136 can be used in place of MATH 124, MATH 125, MATH 126, and MATH 308.)
These physics and mathematics courses are required prerequisites for junior-level work in physics not only at the UW but also at most colleges and universities in the United States. Students who do not complete them during the first two years in college will either need to take more than four years to earn a degree or will be limited to a minimal course of study for graduation in four years.

Department Admission Requirements

Students in good academic standing may declare the major at any time by visiting the department advising office to complete the necessary paperwork.

Major Requirements

~~Minimum 86 credits, including the following:~~
1. *Core courses (~~38~~ credits):* PHYS 121, PHYS 122, PHYS 123, PHYS 224, PHYS 225, PHYS 227~~, PHYS 228~~, PHYS 321, PHYS 322, PHYS 334.
~~*2. Upper-division lecture courses in modern physics (3-4 credits):* Either PHYS 315 or PHYS 324.~~
~~*3. Upper-division physics laboratory courses (6 credits):* Two courses from PHYS 331, PHYS 335, PHYS 431, PHYS 432, PHYS 433, or PHYS 434.~~
~~*4. Research and seminars (3 credits):* Choices include PHYS 401, PHYS 402, PHYS 403; or PHYS 485, PHYS 486, PHYS 487; or PHYS 491, PHYS 492, PHYS 493; or PHYS 494, PHYS 495, PHYS 496; or ASTR 480. 1-3 credits of independent research that has significant physics~~

~~content in a cognate subject (astronomy, chemistry, etc.) may be substituted for 1-3 credits of the above choices with approval of the adviser.~~

~~5. *Upper-division lecture courses:* Two courses from an approved list of upper-division lecture courses in physics or cognate subjects.~~

6. *Mathematics (21 credits):* MATH 124, MATH 125, MATH 126, ~~MATH 324, and one from MATH 308, MATH 318, or AMATH 352~~.

~~7. *Related sciences (9 credits):* Selected from physical or biological sciences (other than physics, mathematics, or computer science) or from the history or philosophy of science, in addition to any courses in these fields taken to satisfy requirement 5, above.~~

8. At least 12 credits of the physics courses presented to satisfy requirements 1 through 5, above, shall be in physics courses numbered 300 or above taken at the UW.

9. A minimum grade of 2.0 is required in all courses presented in fulfillment of requirements 1 through 5, above.

~~10. Students who plan graduate study in physics are strongly advised to complete PHYS 323, PHYS 324, PHYS 325, PHYS 328, as well as several of the following: PHYS 231, PHYS 232, PHYS 331, PHYS 421, PHYS 422, PHYS 423, PHYS 424, PHYS 425, PHYS 426, PHYS 431, PHYS 432, PHYS 433, and AMATH 401, AMATH 402, AMATH 403~~.

Seattle: New Options in Applied Physics, Biophysics, Comprehensive Physics, and Teaching Physics within the Bachelor of Science degree in Physics (PHYS-20100210A/B/C/D)

Tri-Campus Review Comments:

NA